



Evaluation energy efficiency of bioconversion knot rejects to ethanol in comparison to other thermochemically pretreated biomass



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HIGHLIGHTS

- ▶ Energy efficiency of bioconversion sulfite pulp mill rejects and thermochemically pretreated biomass.
- ▶ Effects of disk refining on bioconversion of sulfite pulp mill rejects.
- ▶ Rejects show superior energy efficiency over pretreated biomass.

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ABSTRACT

Rejects from sulfite pulp mill that otherwise would be disposed of by incineration were converted to ethanol by a combined physical–biological process that was comprised of physical refining and simultaneous saccharification and fermentation (SSF). The energy efficiency was evaluated with comparison to thermochemically pretreated biomass, such as those pretreated by dilute acid (DA) and sulfite pretreatment to overcome recalcitrance of lignocelluloses (SPORL). It was observed that the structure deconstruction of rejects by physical refining was indispensable to effective bioconversion but more energy intensive than that of thermochemically pretreated biomass. Fortunately, the energy consumption was compensated by the reduced enzyme dosage and the elevated ethanol yield. Furthermore, adjustment of disk-plates gap led to reduction in energy consumption with negligible influence on ethanol yield. In this context, energy efficiency up to 717.7% was achieved for rejects, much higher than that of SPORL sample (283.7%) and DA sample (152.8%).

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1. Introduction

Cellulosic ethanol represents the best sustainable, secure, and renewable alternative to fossil fuels, and now becomes the focus of worldwide research and investment (Badger, 2002). Cellulosic ethanol is produced from lignocellulose, a structural material that comprises much of the mass of plants, such as corn stover, switchgrass, and woodchips (Sun and Cheng, 2002; Zaldivar et al., 2001). Production of cellulosic ethanol has the advantage of abundant and diverse raw materials compared to ethanol processes that use corn and cane, but requires a greater amount of physicochemical pretreatments to make the sugar monomers available to the microorganisms that are typically used to produce ethanol by

fermentation (Alvira et al., 2010). Furthermore, the pretreatment of lignocellulose feedstocks, such as the commonly used acid hydrolysis, steam explosion, and ammonia fiber expansion, are rather energy intensive due to the required extreme conditions such as high temperature and high pressure, making it a major bottleneck hindering economic bioconversion (Cardona Alzate and Sánchez Toro, 2006; Hamelinck et al., 2005; Zhu and Pan, 2010). In this context, efforts had been contributed to biological pretreatment to replace or complement thermochemical methods for biofuel production with the purpose of process energy reduction (Lemée et al., 2012; Salvachúa et al., 2011). Biological pretreatments was verified a promising technique and has advantages in biofuel production, but at the same time it was recognized very slow and requires careful control of growth conditions, thus less attractive commercially (Cheng and Timilsina, 2011; Zheng et al., 2009). Considering the intensive energy consumption of thermochemical pretreatments and time consuming biological pretreat-

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